Ontario Geological Survey

Northern Ontario
Engineering Geology Terrain Study 36

NORTHWEST ANGLE AREA

(NTS 52E/SE and part of 52E/SW)
Districts of Kenora and Rainy River

Compliments of
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by
D.R. Hallett and M.A. Roed

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MAP
(accompanying report)

Map 5056 (coloured) – Northern Ontario Engineering Geology Terrain Study, Data Base Map, Northwest Angle (NTS 52E/SE and part of 52E/SW). Scale 1:100 000.

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D.R. Hallett[1] and M.A. Roed[2]

1.0 INTRODUCTION

This report and the accompanying map present the results of an engineering geology terrain study for the Northwest Angle area, Districts of Kenora and Rainy River. The area, which covers NTS block 52E/SE and part of 52E/SW, lies between Latitudes 49°00'N and 49°30'N and Longitudes 94°00'W and 95°10'W. The report and map form part of a series of publications which provide similar terrain data for approximately 370 000 km^2 of northern Ontario.

The purpose of this study is to provide an inventory of engineering geology terrain conditions that will serve as a basic data framework for engineering and resource planning activities, at a level of detail consistent with a scale of 1:100 000. The terrain information is contained on the Data Base Map (OGS Map 5060, accompanying this report).

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Interpretation of 1974 black and white aerial photographs, at a scale of approximately 1:50 000, formed the basis of the terrain mapping process. The interpretation was compared to relevant published information for the study area. In addition, two automobile field trips were conducted in 1978, an early reconnaissance trip to identify major terrain units and a later one to verify the airphoto interpretation. Thus, the Data Base Map represents a reconnaissance overview of the engineering conditions of the terrain.

An engineering terrain legend was developed to facilitate the mapping and to provide a common information base for the entire map series. This legend is shown on the accompanying Data Base Map. Further discussion on the mapping techniques, legend format, and possible uses of this engineering geology information is available in the Ontario Engineering Geology Terrain Study Users' Manual (Gartner, Mollard, and Roed, 1980), a companion publication to this series of maps and reports.

Appreciation is expressed to the Ontario Geological Survey for providing a manuscript copy of the aggregate inventory map for the area, prepared by E.V. Sado.

2.0 GEOLOGIC SETTING

The Northwest Angle area is underlain by crystalline bedrock of Precambrian age, which is covered by a thin, discontinuous mantle of Quaternary surficial deposits.

Rugged rocky uplands and lowlands dominate the map-area. Ground moraine occurs as a thin, patchy mantle throughout the bedrock terrain. Glaciofluvial deposits occur mainly as small, thin pockets throughout the bedrock and moraine units. Glaciolacustrine plains and organic terrain are prominent in the southern and north-western parts of the map-area, although small patches of organic terrain are scattered fairly evenly throughout. Alluvium occurs along most streams, but is generally poorly developed.

2.1 BEDROCK GEOLOGY

The map-area, which lies within the Wabigoon Belt in the Superior Structural Province of the Canadian Shield, is underlain by two contrasting bedrock types, both of Early Precambrian age. The oldest rocks are supracrustal and comprise highly folded, curvilinear belts of mafic to felsic metavolcanics with lesser amounts of metasediments, mafic and ultramafic intrusive rocks, and felsic igneous and metamorphic rocks. These belts occur in the northern and eastern parts of the area, particularly as a ring around the large elliptical body of felsic igenous and metamorphic rocks on the Aulneau Peninsula. This body, together with similar rocks in the southern part of the area, comprise the second bedrock type and underlie approximately 80% of the map-area. Northwest-trending diabase dikes of Middle to Late Precambrian age cut all other rock types in several localities (Davies and Pryslak 1967).

Areas of high mineral potential occur in the northwest corner of the area (for copper) and near Sioux Narrows and Robinson Lake on the eastern margin of the area (for gold-silver). All three areas are underlain by metavolcanics. Mineral potential of the felsic igenous and metamorphic rocks is rated as "least" (Springer 1978).

2.2 QUATERNARY GEOLOGY

Northwestern Ontario has been affected by several stages of continental glaciation during the Pleistocene. However, only deposits of the last glaciation, the Laurentide of Wisconsinan age, are preserved in the Northwest Angle area. The ice began to advance approximately 100 000 years ago and travelled as far south as central Wisconsin before receding. The ice disappeared from the Northwest Angle area approximately 15 000 years ago (Prest 1970). Zoltai (1961) gives a more complete account of the glacial history of the region.

Widespread stagnation of the ice mass resulted in the deposition of a variety of surficial materials. Till was deposited directly by the ice in the form of ground moraine. In the rugged rocky uplands characteristic of the eastern part of the area, the glacier overdeepened valleys, rounded off bedrock outcrops, and left scattered patches of moraine and boulders. Meltwater from the glacier formed glaciofluvial outwash deposits and accumulated in lowlands to form glacial lakes. These lakes

grew in size and eventually coalesced to form an enormous body of water called Glacial Lake Agassiz. Deposits of glaciolacustrine silt and clay occur wherever this lake covered the land in the southern and northwestern parts of th map-area. Numerous glaciolacustrine beach deposits were formed. In some localities, bedrock hills were swept clean of material during high water stages of Glacial Lake Agassiz, as evidenced by numerous bare bedrock knobs and ridges. In other parts of the area, bedrock has been covered by the lake deposits.

The complete disappearance of glacial ice and gradual draining or drying up of glacial lakes marked the end of the Pleistocene Stage of the Quaternary Period. Since that time, approximately 9 000 years ago (Prest 1970), modern streams have developed alluvial flood plains and organic deposits have accumulated in wet depressions. These deposits are nonglacial in origin and, together with the various glacial materials, comprise the variety of Quaternary unconsolidated deposits that forms a discontinuous mantle over the bedrock in the Northwest Angle area.

2.3 PHYSIOGRAPHY

The physiography of the area is dominated by Lake of the Wood, with its many rocky islands and bordering rocky lowlands. Relief varies from low to moderate (less than 60 m). Elevations range from approximately 323 m at the level of Lake of the Woods to more than 366 m on the Aulneau Peninsula.

3.0 ENGINEERING TERRAIN UNITS

Engineering terrain units are composed of a combination of various materials (unconsolidated and/or bedrock) which form recognizable landforms with certain engineering characteristics. Major terrain unit groups. and the engineering significance of each, are discussed in detail. These include bedrock terrain (RN, RR, RP), glaciolacustrine plains (LP), and organic terrain (OT). Ground moraine (MG), glaciofluvial outwash (GO) and alluvial plains (AP) are not considered as major units in this map-area and are discussed in less detail. A diagrammatic sketch of a typical terrain setting is given in Figure 1. Table 1 summarizes the characteristics and engineering significance of the major terrain units in the Northwest Angle area.

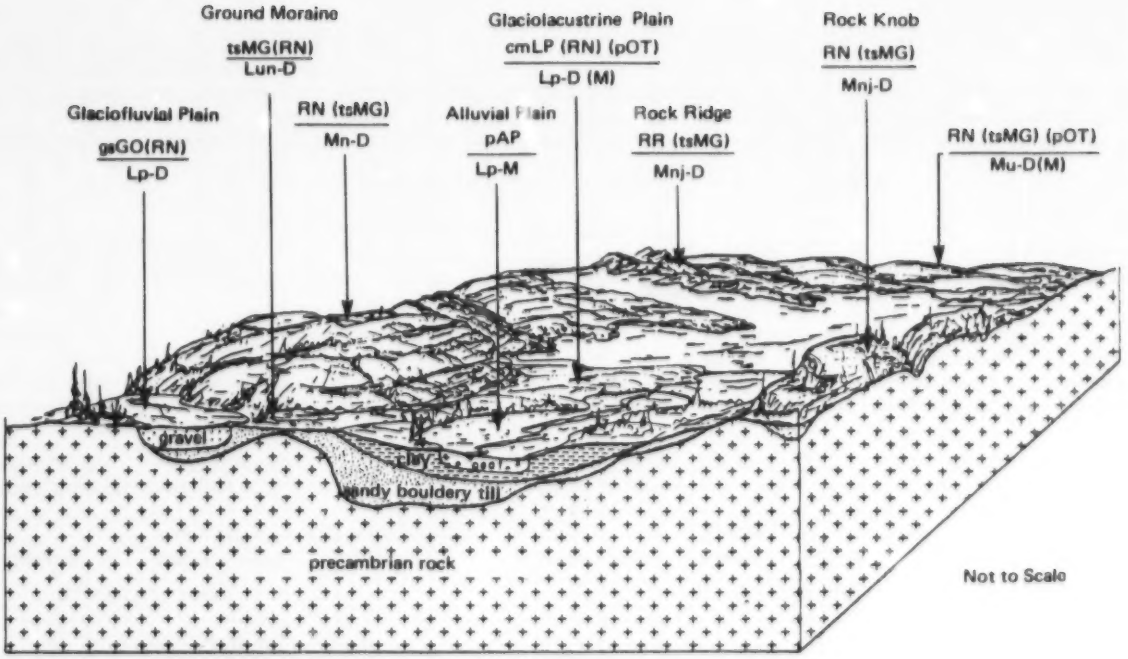

FIGURE 1 – DIAGRAMMATIC SKETCH SHOWING TYPICAL TERRAIN TYPES AND THEIR REPRESENTATIVE LETTER SYMBOLS.

TABLE 1 SUMMARY OF TERRAIN UNIT CHARACTERISTICS AND ENGINEERING SIGNIFICANCE, NORTHWEST ANGLE AREA

CLASSIFICATION		ENGINEERING USE				
Terrain Unit and Location	**Material; Relief; Topography, Drainage**	**General Construction**	**Transportation Routes**	**Waste Disposal**	**Groundwater Supply**	**Major Constraints**
BEDROCK TERRAIN (RN), dominates the map-area	rock; low to moderate relief; undulating to rugged; dry	excavations and fill necessary for most construction	blasting is required; aggregate must be imported	pollution potential is high	adequate domestic supply from deep wells	blasting; lack of aggregate
GLACIOLACUSTRINE PLAINS (LP), mainly in Morson Township and on Bigsby Island and Big Island	clay and silt (cm); low relief; planar to undulating; dry	easy excavation; low bearing capacity for large structures; frost susceptible	aggregate must be imported	suitable for waste disposal where deposits are thick and the water table is low	large diameter shallow wells produce enough water for domestic use	frost susceptible; poor drainage in places
ORGANIC TERRAIN (OT), throughout the area	peat (p); low relief; planar; wet	low bearing capacity; high frost susceptibility; high compressibility	unsuitable subgrade except for light vehicle roads	high pollution potential	poor	highly frost susceptible; low strength; poor drainage

Comments: Glaciofluvial sand and gravel (sgGO) was mapped only in two localities, but it also occurs as small pockets in other terrain units. Ground moraine till (tsMG) occurs throughout much of the area as patches in bedrock terrain, and rarely exceeds 5 m in thickness. Alluvial plains have been mapped on Splitrock and Barras Creeks. Others occur but are too small to map. Glaciolacustrine beaches occur in the southwestern part of the area.

3.1 BEDROCK

Examples: $\frac{\text{RN(tsMG) (cmLP)}}{\text{Mnj-D}}$ $\frac{\text{RN(pOT)}}{\text{Mnj-D}}$

$\frac{\text{RR (cmLP) (tsMG)}}{\text{Lrw-D}}$ $\frac{\text{RP(cmLP) (tsMG)}}{\text{Lp-D}}$

Bedrock terrain refers to those areas that are underlain by rock, either at the surface or within 1 to 2 m of the surface. This unit, which dominates the northern and eastern parts of the area, is generally in the form of rolling (n), rugged (j) rock knobs (RN) of moderate relief (M). Ground moraine (MG) is the most common subordinate landform, although glaciolacustrine (LP) deposits do occur. Topography changes to low relief (L) near the main body of Lake of the Woods and is less rugged in character. Landforms have been wave-washed (w) in places by glacial lake action, especially in low-lying areas. Bedrock terrain on the Aulneau Peninsula is bare, of moderate relief, and rugged (Mnj). Poorly drained (W) organic peat deposits (pOT) occur in topographic depressions.

Terrain around Shoal Lake in the western part of the map-area, on Painted Rock Island in the central part, and in Morson Township in the southern part is characterized by bedrock of low relief (L) that is planar (RP) and/or ridged (RR) in character. Glaciolacustrine deposits (cmLP) form the major subordinate landform in these areas.

The principal engineering significance of bedrock terrain is that it is difficult and expensive to excavate. Blasting is required for all subsurface excavations. Extensive cut-and-fill operations are required for transportation route construction in rugged terrain, in order to eliminate excessive horizontal and vertical alignments. High rugged slopes pose problems for general construction in some localities. Although there are many small sand and gravel deposits in bedrock terrain that provide sufficient construction material for minor access roads, major transportation routes will require importation of suitable granular material.

Groundwater potential is generally poor, except in fault zones where it may be possible to obtain substanial quantities of water. Bedrock terrain is not suitable for septic system operation, except where there is a thick (at least 1.5 m) of suitable surficial material. The unit is not suitable for near-surface waste disposal.

3.2 GROUND MORAINE

Examples: $\frac{\text{tsMG(RN)}}{\text{Lnw-D}}$ $\frac{\text{tsMG/RN(sgGO) (RN)}}{\text{Mnw-D}}$

Ground moraine composed of sandy till (tsMG) occurs as a subordinate landform throughout the area, forming a thin, discontinuous mantle over bedrock. Three small areas where ground moraine is the dominant landform have been mapped, two along the shore of Lake of the Woods near the southern margin of the area and the other around South Narrow Lake on the eastern margin. Extensive thick deposits of ground moraine do not occur in this map-area.

The usefulness of the sandy bouldery till is limited because of the thin discontinuous nature of the ground moraine unit. Till is used as a construction material for forest access roads and for foundations. Aggregate must be imported for major transportation route construction. Because slopes tend to be less rugged and steep in this unit than in bedrock terrain, there will be fewer construction problems. Deposits are generally too small and thin to have much groundwater potential. Ground moraine is suitable for septic drain tile fields where the till deposits are at least 1.5 m thick.

3.3 GLACIOFLUVIAL

Examples: $\frac{\text{sgGO(RN)}}{\text{Ln-D}}$ $\frac{\text{sgGO(tsMG) (RN)}}{\text{Mn-D}}$

Glaciofluvial outwash (GO) composed of sandy gravel (sg) has been mapped at two localities in the Northwest Angle area, one in Morson Township near the southern margin of the area and the other on Whitefish Bay of Lake of the Woods near the eastern margin. Small pockets of sand and gravel outwash occur locally in bedrock and ground moraine units.

Sand and gravel of glaciofluvial origin are important granular construction materials; however, since deposits in the Northwest Angle area are small, the significance of the unit is limited.

Groundwater potential is low since the deposits are relatively thin and probably above the water table. Where the water table is high, groundwater potential is excellent. Outwash is not suitable for waste disposal, since contaminant migration could be extensive.

3.4 GLACIOLACUSTRINE

Glaciolacustrine terrain is composed of two distinct landforms, plains and beaches, as described below.

3.4.1 Glaciolacustrine Plains

Examples: $\frac{\text{cmLP(RN)}}{\text{Lpn-D}}$ $\frac{\text{cmLP/RP}}{\text{Lp-D}}$

Glaciolacustrine deposits, consisting of calcareous varved silt and clay (cmLP), occur in the southern and northwestern portions of the Northwest Angle area. These fine-grained deposits form undulating plains of low relief (Lpu). The sediments are shades of grey in colour, but a maroon-coloured band is visible in some road cuts (Zoltai 1961). The most common subordinate landforms in this unit are rock knobs (RN) and rock plains (RP). Glaciolacustrine deposits also occur as a subordinate landform in association with bedrock terrain, mainly at low elevations close to the shore of and on the islands in Lake of the Woods. At higher elevations, deposits of silt and clay are local and discontinuous. Glaciolacustrine plains are generally dry.

The fine-grained deposits of silt and clay make poor construction materials, so that importation of aggregate is often necessary. Transportation route construction and general near-surface construction are inexpensive due to the ease of excavation. However, because of the high percentage of silt, the deposits are frost susceptible. At times of heavy precipitation or rapid snow melt in the spring, flooding may occur in glaciolacustrine terrain due to flat slopes, slow runoff, and the relatively low permeability of the materials. Although the gritty layers which can occur in the deposits improve the strength parameters, these fine-grained sediments are still relatively weak and have low bearing capacity and shearing resistance. Minor slumping and erosion occur along most streams and are important considerations in the design and construction of bridges.

Although the moisture content of the silt and clay is very high, groundwater potential is poor due to the low effective permeability and porosity of the unit. Shallow, large bore wells should provide sufficient water for domestic use. Substantial buried-valley aquifers may occur below the glaciolacustrine unit in some places, but none were identified in this study. The terrain is suitable, in terms of effluent attenuation and low percolation rates, for septic drain tile fields and near surface waste disposal.

3.4.2 Glaciolacustrine Beaches

Coarse-grained sand (s) and gravel (g) of glaciolacustrine origin form numerous small abandoned beach ridges (LB) in the southern portion of the area particularly in Morson Township, and on Big Island and Bigsby Island in Lake of the Woods. The beach ridges vary in height from less than 1 m to approximately 5 m and in width from 15 to 150 m. Beaches are also found on the lower flanks of some bedrock knobs (RN) and occasionally in ground moraine (MG). Glaciolacustrine clay and silt (cmLP) underlie and occur between the ridges, while organic deposits have accumulated on and around some of the ridges.

Sand and gravel beach deposits have considerable potential as local sources of granular construction materials, but are limited to the southern part of the Northwest Angle area. Many beach ridges are inaccessible due to their location on Big Island and Bigsby Island. Transportation routes and general construction can be carried out easily on or near the beach ridges due to the availability of granular material.

Groundwater potential is poor because most beaches occur above the water table. Where the table is high (e.g. on Big Island and Bigsby Island) the groundwater potential is good. The beach ridges are suitable for near-surface waste disposal where they are underlain and surrounded by fine-grained deposits and where a low water table exists.

3.5 ALLUVIAL

Examples: $\frac{\text{mpAP}}{\text{Lp-W}}$

Alluvial plains (AP) composed mainly of silt (m) and peat (p) occur along many creeks and streams in the area, but most are too small to be shown

on the map. Two notable exceptions are those along Splitrock River in the southwest corner of the area and Barras Creek on the Aulneau Peninsula. The deposits are generally wet (W).

Alluvial plains are unsuitable for most engineering uses due to the poor drainage, characteristically high groundwater table, and periodic flooding. Groundwater potential is usually poor, since most alluvium in this map-area is fine-grained. The unit is also unsuitable for waste disposal since the associated stream could become polluted.

3.6 ORGANIC

Examples: $\frac{\text{pOT/cmLP}}{\text{Lp-W}}$ $\frac{\text{pOT}}{\text{Lp-W}}$

Large areas of organic terrain (OT) composed of peat (p) occur throughout the southern part of the area, south of Shoal Lake in the northwest corner of the area, and on Big Island and Bigsby Island in Lake of the Woods. Many smaller deposits occur in bedrock depressions on the Aulneau Peninsula. The deposits vary in thickness and often overlie glaciolacustrine sediments (LP). This is apparent where features such as spits and beaches can be distinguished through a thin layer of peat. Drainage is generally poor (W) and the water table is close to the surface (h).

Construction is difficult and expensive in organic terrain due to the poor drainage conditions and the low strength, low bearing capacity, high compressibility, and extremely high frost susceptibility of the soil materials. The unit is generally poor for engineering or construction use, but light vehicle roads have been built with some success across some of the dryer deposits. Groundwater potential is low and the terrain is not suitable for waste disposal.

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